G S S P Background Paper 5

REACHING MIDDLE-INCOME STATUS IN GHANA BY 2015 WHAT ARE THE CONSTRAINTS AND OPPORTUNITIES FOR RAISING AGRICULTURE PRODUCTIVITY?

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THE GHANA STRATEGY SUPPORT PROGRAM (GSSP)
BACKGROUND PAPERS

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SUMMARY

The Government of Ghana has identified accelerated growth in agriculture as the source of its overall Growth and Poverty Reduction Strategy (GPRS II) and reaching middle-income status by 2015. Using data from the recent Ghana Living Standards Survey (GLSSV) to estimate the determinants of (i) adoption and intensity of adoption of purchased inputs, (ii) crop productivity, and (iii) agriculture income per capita, this paper analyzes the constraints and opportunities for raising agriculture production in order the above challenge.

The main determinants of higher agriculture productivity were purchased inputs, especially fertilizers and pesticides, which had positive impacts on productivity. The marginal returns (or profitability) to use of purchased inputs are large and statistically significant, especially in the forest and savannah zones. None of the purchased inputs was profitable in the coastal zone. These results show that investment in extension and other programs to promote use of fertilizers and pesticides will be important. Of course, given that these inputs are costly, providing credit to farmers to help them acquire the inputs will be important, as is improving their availability through investment in infrastructure and development of input markets.

With the exception of access to telephones, access to services and infrastructure seem to have mixed impacts. For example, households with access to a telephone (either fixed or mobile) were associated greater spending on improved seeds in all but the coastal zone, greater spending on fertilizers and pesticides in the southern savannah zone, and greater spending on hired labor in the forest zone. This suggests that those who are connected are better able to access information and inputs. Districts with better year-round access to roads were associated with lower spending on improved seeds and fertilizers, likely due to lower unit prices of those brought about by lower transactions cost. Districts with better year-round access to roads were also associated with greater spending on hired labor in the northern savannah zone. With the improvement in the road infrastructure and migration of labor to the south, it households do not have adequate family labor to tend their farms and must resort to hired labor to manage their now larger farms. Districts with greater access to markets were associated with greater spending on improved seed in the forest and northern savannah zones, but it was associated with lower spending on fertilizers across the board. Greater access to markets was also associated with opposing effects on spending on hired labor in the coastal and forest zones. These show that different types of policies, strategies, and public investment strategies will be needed in different agroecological zones to promote agricultural intensification, raise agricultural productivity growth, and increase incomes.

In general, increased investment in agriculture research that leads to the development of profitable technologies in local environments will be important. Increased investment in extension and other training programs to promote proper use of improved seeds will also be important. Similarly,

improving the availability of improved seeds and helping farmers to acquire purchased inputs will also be critical.

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1. ON THE ROAD TO MIDDLE-INCOME STATUS

The Government of Ghana, in its Growth and Poverty Reduction Strategy (GPRS II), has declared its new development goal of reaching middle-income status by 2015, hinged on the overall objective of raising the per capita income of Ghanaians to at least US$1,000 by 2015 (NDPC 2005). While it is recognized that accelerated growth will be necessary to reach this goal, structural transformation to be propelled by growth in the agriculture sector has been recognized in order to maximize the benefits of accelerated growth. This is because agriculture is the highest contributor to GDP and provides employment for over 60% of the population, and the bulk of the poor, especially women, are engaged in agriculture. Furthermore, IFPRI's research show that given agriculture's large initial share of the economy, it is impossible to have rapid economy-wide growth without accelerating agricultural growth (Breisinger et al. 2007). Therefore, providing sound evidence on the bio-physical, technical and policy constraints and opportunities for raising agriculture productivity will be invaluable for policy makers to systematically address the challenges facing the sector.

2. RAISING AGRICULTURE PRODUCTIVITY

2.1 Conceptual Framework

Data from the recent Ghana Living Standards Survey (GLSSV), supplemented by data from the core welfare indicators survey (CWIQ) in 2003, are utilized to analyze the determinants of: (i) adoption and intensity of adoption of purchased inputs, (ii) crop productivity, and (iii) agriculture income per capita.

The underlying conceptual framework for the analysis draws from the literature on agricultural household models (Singh et al. 1986; de Janvry et al. 1991), adoption of agriculture technologies (Feder et al. 1985; Feder and Umali 1993), land tenure and productivity (Feder and Feeny 1993; Place and Hazell 1993; Besley 1995), and theories of induced technical and institutional innovation in agriculture (Boserup 1965; Hayami and Ruttan 1985; Pender 1998). These are represented by the following simplified relationships:[1]

$$CROP\ INPUTS_h = f(FARM\ \ FACTORS_h, HOUSEHOLD\ FACTORS_h, BIOPHYSICAL\ FACTORS_c)$$

$$CROP\ OUTPUT_h = f(CROP\ INPUTS_h, FARM\ \ FACTORS_h, HOUSEHOLD\ FACTORS_h, BIOPHYSICAL\ FACTORS_c)$$

$$AG\ INCOME_h = f(CROP\ OUTPUT_h, HOUSEHOLD\ FACTORS_h, BIOPHYSICAL\ FACTORS_c)$$

Crop inputs depend on the factors determining profitability of crop production in general. They depend on farm factors such as land tenure status (which affect the future returns from current practices) and household's endowments of land, labor, livestock, and social capital (which are important for labor, draft power, manure, credit, etc. where markets for such inputs do not function properly or exist). Use of inputs also depend on household's income strategies and access to roads, markets and credit (which affect the ability to purchase or hire inputs); They also depend on biophysical factors such as and rainfall, population density and other village level factors (which affect local comparative advantages).

Crop output is expressed as a function of the inputs used (e.g. improved seeds, inorganic and organic fertilizers, pesticides, hired labor, animal draft power, and other equipment) and farm factors such as type of crops planted, farm size, and land tenure. Household characteristics and biophysical factors discussed above are also important.

[1] For detail description of the models and hypotheses, see Benin (2006) and Pender and Gebremedhin (2006).

Agriculture income is determined by the same factors that affect input use and crop output, particularly income strategies and asset endowment.

2.2 Empirical Approach[2]

Crop inputs: The inputs analyzed here are the major ones including improved seeds, chemical fertilizers, pesticides (insecticides and herbicides), and hired labor. These are measured as the value of the amount used per acre. Given that not all households used any one type of input, we use a Tobit regression (Maddala 1993) to estimate equation 1.

Crop output. Households produce multiple crops on their farmlands and so we use the value of production to aggregate all the crops produced by the household, based on the households own valuation. We estimated two sub-equations. In the first one, we use the value of production of staple grains, other field crops and cash crops harvested within the last 12 months that the household was interviewed. In the second regression, we used the total value of all crops produced, including those harvested in piecemeal (i.e. roots, tuber and other starchy crops, fruits, vegetables, etc). In the GLSSV survey, the value of the latter was obtained for only those households that had harvested any output within the last two weeks at the time of the interview. We multiplied the value by 26 to obtain the annual value of production. This means that the value of total production of households that cultivated these crops but did not harvest any in the last two weeks at the time of the survey are underestimated. Therefore, we include a dummy variable to capture the difference. As we shall see later, the coefficient associated with this dummy variable suggests that the underestimation ranges from about 44% in the northern savannah zone to about 109% in the coastal zone. In both regressions the dependent variable is the value of output per acre, which are estimated by ordinary least squares (Greene 1993).

Agriculture income. Agriculture income includes the value of total crop production as discussed above plus the value of livestock sales and own consumption, renting of draft animals, and production associated with dairy, eggs, hunting, snails, mushrooms, wild crops, beekeeping and fisheries. The dependent variable is agriculture income per capita, which also is estimated by ordinary least squares.

Explanatory variables. The explanatory variables were chosen to represent the conceptual factors discussed above. We also include dummy variables to control for regional location and time of the survey, which took place over a two-year period form January 2005 to December 2006. These dummy variables help to capture any unobserved differences across space such as prices. Detail description of the variables and their summary statistics are given in Table 1. The analyses are based

[2] For discussion of the estimation issues and how they are dealt with, see Benin (2006) and Pender and Gebremedhin (2006).

on 4768 of the total 8686 household observations, i.e. those with data on all the relevant factors of interest in this paper.

Agroecological disaggregation. In order to better analyze the determinants of adoption and intensity of adoption of purchased inputs, crop productivity, and agriculture income per capita, we estimate the above equations separately for four distinct agroecological zones: coastal, forest and northern and southern savannah, which are described in detail in the Annex 1. The rainfall amount and distribution and the soil type are the main differentiating factors across the zones and these determine the length of the growing period as well as the suitability of agricultural enterprises. The northern savannah zone typically has one rainy season, with millet and guinea corn being the major staples, although maize, groundnuts and vegetables are also cultivated. The other zones are characterized by a bi-modal rainfall distribution, and so it is the amount of rainfall that drives food production activities. The forest zone has the most amount of rainfall, followed by the coastal zone. Due to the low rainfall in the northern savannah zone, most of the irrigation projects in Ghana tend to be located there.

In the following sections, we present the results of the analyses. First, we analyze differences across the agroecological zones in the mean values of the variables discussed above, without taking into account any factors that may have contributed to the observed differences. This sets the stage for the results of the econometric analysis, which examines the factors contributing to the observed differences across households in their spending on purchased inputs, crop productivity and agricultural incomes, both across and within agroecological zones. This is done to avoid the one-size-fits-all type of policy implications that derive from estimating a single national equation.

2.3 Descriptive Statistics

Farm characteristics. Households in the northern savannah zone on average cultivate the largest farmlands (about 10.4 acres per household). This is followed by the forest zone (7.1) and then the coastal and southern savannah zones (about 6 acres each). The farmlands cultivated by households were fragmented, with each household cultivating an average of two plots (ranged from 1 to 14). The level fragmentation, in terms of both the number of plots and the index[3], was highest in the savannah zone. Compared to farmlands that were purchased or used free of charge, more than 50% of the farmland cultivated by households was obtained through distribution by the village, which was the more dominant channels of obtaining farmland in the northern savannah and coastal zones. While rental (both fixed-fee and sharecropped) was common in the coastal, forest and southern savannah

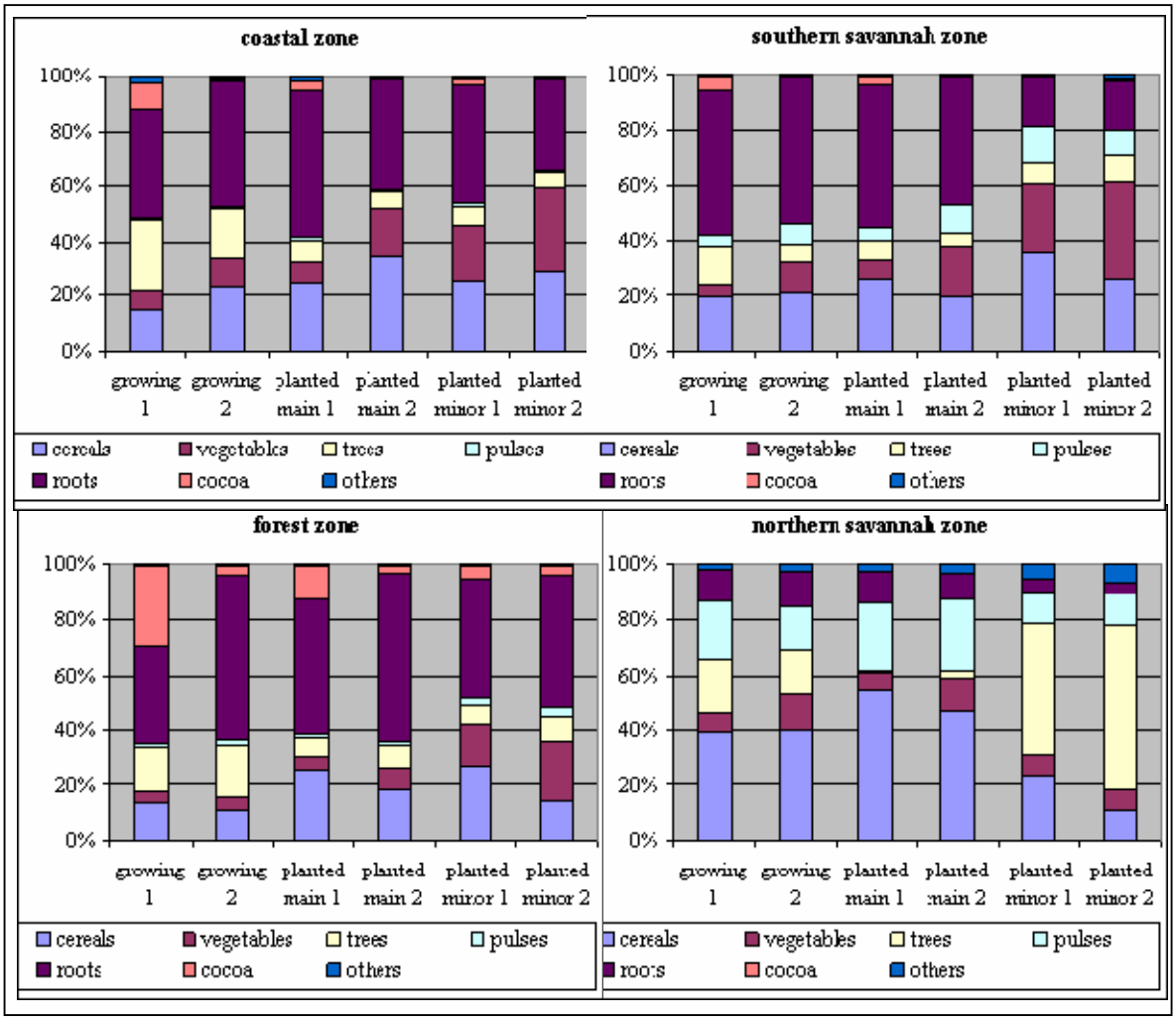
[3] The farm fragmentation index is measured by the Simpson index ($1-\sum_k \delta^2$) where δ is the share of kth plot in total farm size (Blarel et al. 1992). Larger values represent lower concentration in any one plot and, therefore, greater fragmentation.

zones, they were virtually non-existent in the northern savannah zone, which is expected given the communal land tenure system that exists in the latter.

Spending on purchased inputs and irrigation: There was negligible use of irrigation by households across the board (less than 0.5%), with households in the southern savannah zone accounting for the bulk of the spending on irrigation. This is not surprising as it is the zone with the greatest irrigation potential in the country. Households in the southern savannah zone also spent the most on purchased inputs, including improved seed, pesticides and hired labor, averaging between 19,000 and 153,000 cedis per acre on each of these inputs. Together with the earlier result of the southern savannah zone having the smallest average farmland size and most fragmentation, the above results suggest that intensive agriculture production is taking place in the southern savannah zone. Therefore, it will be important to promote seeds that will lead to profitable outcomes if the intensification process is to be sustained. Households in the forest zone had the highest expenditure on fertilizers (about 32,000 cedis per acre). This may be contrary to common belief that the forest zone is relatively more fertile and, therefore, households in that zone spend less on chemical fertilizers. Use of organic fertilizers was highest in the northern savannah zone, probably due to better availability of dung from livestock, which is reflected in the ownership of livestock being highest in the zone.

Crops cultivated. In the GLSSV survey, households were asked to indicate the two most important crops in terms of revenue that were already growing on their farmland at the time of the survey as well as those that they planted during the main and minor cropping seasons, respectively. Analyzing this data in terms of the frequency of plots planted to specific crops, Figure 1 shows that cereals and pulses are much more common in the northern savannah zone.[4] There also seem to be several fruit trees planted in the zone during the last minor season. Roots (roots, tubers, plantain and other starchy crops) are dominant in all but the northern savannah zone. In the northern savannah zone, the root crops (especially yams and sweet potatoes) are grown in valleys where moisture conditions are favorable. As expected, cocoa cultivation is restricted to the forest zone, where the trees were already growing with little new planting taking place. Vegetables are more common in the coastal and southern savannah zones, where they are mostly cultivated in the minor season, and where the opportunity to irrigate also is more likely to be available or demand for the output is higher. Clearly, not only are there differences in the crops cultivated by zone, but also the season in which they are cultivated.

[4] See Annex 2 for description of crops.



Source of data: GLSSV (GSS 2007).

Figure 1. Two most important crops cultivated by households, by agroecological zone

Livelihoods and asset endowments. Subsistence agriculture accounted for the bulk of the livelihood strategies pursued by households, in terms of the proportion of adult household members engaged in those activities (more than 65%). Only 19% to 30% of household members were engaged in market-oriented activities, with the largest proportion occurring in the coastal and northern savannah zones. Only about 10% of the members were engaged in non-farm activities, a strategy that was more prominent in the coastal zone and least in the northern savannah zone, which is expected given the relatively more non-farm (or urban) employment opportunities that exist in the coastal zone. Households owned an average of 1.5 tropical livestock units (TLUs), with those in savannah zones owning more (3.6 and 1.4 TLUs in the north and south, respectively) compared to their counterparts

in the coastal (0.6 TLUs) and forest (0.4 TLUs) zones.[5] This is also expected given the low population density and better grazing conditions that exist in the zones. Similarly, ownership of equipment (including tractors, ploughs, carts, spraying machine, outboard motors, canoes, fishing nets, etc.) was highest in the savannah zones. The value of equipment owned was between two and three times higher, compared to the other two zones.

Access to services, telecommunication and infrastructure. Basically, although access to these was very high at the national level, access was relatively biased against the northern savannah zone, especially regarding access to water supply or markets.

Value of crop production and agriculture income. Households in the southern savannah zone realized the highest value of crop output as well as agricultural income per capita, followed by the forest and coastal zones, and the northern savannah zone. This is consistent with national statistics as well as the observed high intensity of crop production in the southern savannah zone, followed by the forest zone. On the whole, the value of total crop production was about 2.5 million cedis per acre, while agricultural income was about 2.8 million cedis per capita.

The northern savannah zone particularly stands out when comparing the mean values of most of the variables across the four zones. The zone is characterized by larger households, lower education attainment levels, little non-agricultural occupation activities and, thus, lower livelihood options, and little use of hired labor (suggesting labor abundance) and pesticides. This is consistent with the chronic high poverty rates that are observed in the northern parts of Ghana. Due to the poor market opportunities of the zone, use of purchased inputs (especially chemical fertilizers and pesticides) is not likely to profitable. However, promoting improved seeds of crops grown in the region that respond well to manure will be beneficial.

In the next section, we analyze the impact of various factors in the adoption and use of purchased inputs, value of crop production per acre, and agriculture income per capita. Then, we examine how the impacts of the various factors differ in each of the four agroecological zones.

2.4 Econometric Results

Spending on purchased inputs (Tables 2a–d)

Impact of farm size and farm fragmentation

With all other factors remaining the same, larger farms are associated with lower probability and expenditure on purchased inputs per unit area, particularly on seed in the coastal and northern savannah zones, fertilizers and pesticides in the forest zone, and hired labor in the forest and southern savannah zones. Larger farms in the southern savannah zone, on the other hand, were associated with

[5] Livestock was aggregated by using the following weights: cattle (1), donkeys and pigs (0.36), sheep and goats (0.09) and rabbits and poultry (0.01).

greater spending on fertilizers. Although the reasons for the observed differences in the impact of the variables across different zones are important to know, the message here is that the conventional view of an inverse relationship between farm size and intensity of production does not hold everywhere in Ghana, suggesting that the initial level of input use may itself be important, being rather low to start with. Thus, the argument of reducing farm size to induce intensification does not hold here. The impact of farm fragmentation (i.e. number of plots and concentration index) on spending on purchased impacts was mixed. While households operating several plots were associated with greater spending on seeds, pesticides and hired labor in some zones, those operating more fragmented plots (lower concentration) were associated with lower spending on the same inputs in those same zones. Here too farmers usually use fragmentation to diversify into different local growing conditions to minimize any bio-physical risks, which may require different crops or inputs. Thus, reducing fragmentation will not necessarily lead to cropping intensification everywhere. The reasons for fragmentation have to be first examined case by case before any interventions, where needed, can be put into place.

Impact of land tenure and rental markets

Compared to farmlands that were purchased or used free of charge, households with greater proportion of rented plots (either fixed-fee or sharecropped) in their farmland portfolio were associated with greater spending on some inputs, for example seeds in southern savannah, fertilizers in the forest zone, pesticides in the forest and northern savannah zones, and hired labor in all but the northern savannah zone. Although the effect of rented plots on input use is not the same for every input, together, the results suggest substantial mobility of scarce resources induced by the land rental market, thereby helping to transfer land to those with the resources to potentially improve the productivity of the land resource base and engage in intensive crop production. Therefore, policies that promote effective functioning of such markets where they are already developed will be beneficial. Households with greater share of farmland obtained from the village (or the more traditional from of land tenure) had mixed impacts. They were associated with greater spending on seed in the northern savannah, greater spending on fertilizers in the forest and southern savannah zones, and greater spending on pesticides in the forest zone. However, they were associated with lower spending on seed and hired labor in the coastal and northern savannah zones, respectively. Again the conventional view that traditional land tenure systems do not promote cropping intensification is not supported, and it seems that tenure security, which is the more constraining factor, is not an issue here.

Impact of household characteristics (gender, education, assets, and livelihoods)

Generally, households with more educated members were associated with greater spending on purchased inputs, including improved seeds in all but the forest zone, fertilizers and pesticides in the

savannah zone, and hired labor in the forest zone. This supports the large body of evidence on the positive impact of education in promoting adoption and increasing the intensity of adoption of improved agricultural technologies. Larger assets in terms of the number of tropical livestock units and value of farm equipment also were associated with greater spending on several purchased inputs in most of the zones. Assets, especially small livestock can be used to finance purchase of inputs either directly through their sale or indirectly as collateral to obtain credit. Thus, interventions that create more productive assets for households will be important for promoting agricultural intensification across the board, even if the level of impact differs across zones.

Male-headed households were also associated with greater spending, particularly spending on fertilizers, pesticides and hired labor in the forest zone. Furthermore, households headed by the elderly were associated with lower spending on inputs, particularly on improved seeds in the forest and northern savannah zones and pesticides in the forest and southern savannah zones. Together, these two results suggest that households headed by females and the elderly in those zones, all other factors remaining the same, are less likely to engage in intensive production activities and, therefore, more likely to have lower crop productivity levels and incomes. A commonly cited reason for such findings is that the elderly and women tend to have poor access and resources. However, these factors, as well as household size, education, etc., are already controlled for in the analysis. Therefore, the differences are likely to be due to cultural and social factors. Nevertheless, the results obtained here suggest that specific interventions targeting the elderly and female headed households in those zones will be needed. As expected households with a greater proportion of their members employed were associated with greater spending on purchased inputs, particularly fertilizers and pesticides in the southern savannah zone, and improved seeds in the northern savannah zone. Compared to subsistence farming, engagement in other different income-generating activities had different impacts. Engagement in market-oriented agriculture production activities was associated with lower spending on pesticides and hired labor, probably reflecting consumer preference for products with low use chemicals, which in turn reduces the need for hired labor. Engagement in non-farm activities was associated with greater spending on purchased inputs, particularly on fertilizers, pesticides and hired labor in the northern savannah zone. Thus, addressing cash constraints by improving non-farm livelihood opportunities for rural household members will be crucial for promoting substantial investment in land-improving management technologies in the zone.

Impact of access to services and infrastructure

With the exception of access to telephones, access to services and infrastructure has mixed impacts. For example, households with access to a telephone (either fixed or mobile) were associated with greater spending on improved seeds in all but the coastal zone, greater spending on fertilizers and pesticides in the southern savannah zone, and greater spending on hired labor in the forest zone. This suggests that those who are connected are better able to access information and inputs. Districts with

better year-round access to roads were associated with lower spending on improved seeds and fertilizers, likely due to lower unit prices of those inputs brought about by lower transportation and transactions cost. Districts with better year-round access to roads were also associated with greater spending on hired labor in the northern savannah zone. With the improvement in the road infrastructure and migration of labor to the south, it is likely that households do not have adequate family labor to tend their farms and must resort to hired labor to manage their now larger farms. Districts with greater access to markets were associated with greater spending on improved seed in the forest and northern savannah zones, but it was associated with lower spending on fertilizers across the board. Greater access to markets was also associated with opposing effects on spending on hired labor in the coastal and forest zones.

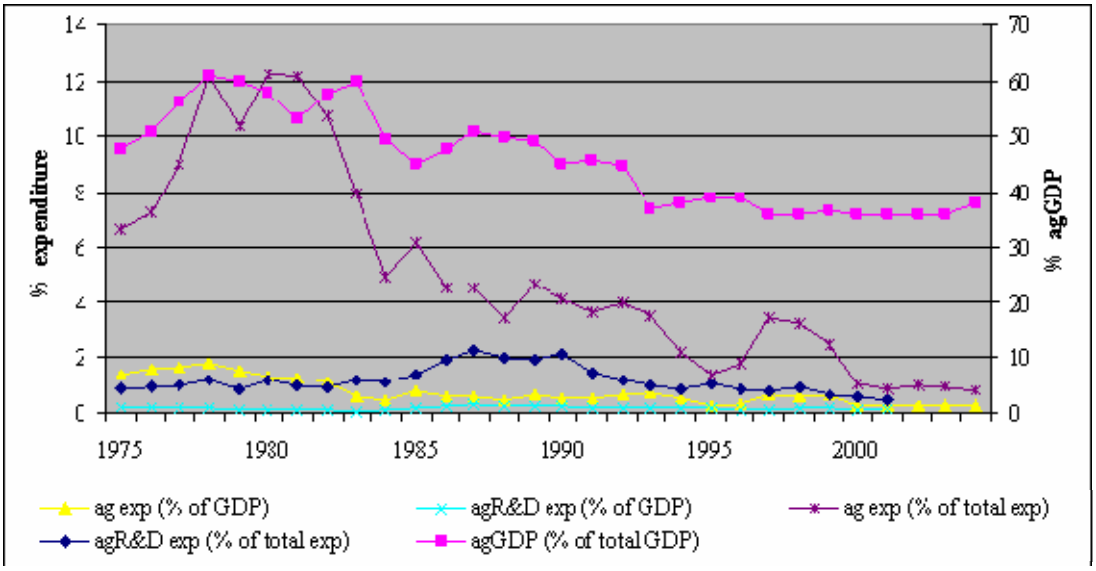
Value of crop production (Table 3a–c)

The discussion in this section focuses on the results associated with production of staple grains, field crops, and cash crops (Tables 3a and b). Table 3c shows results of estimating the value of total production per acre, including crops that were harvested in piecemeal (i.e. roots, tuber and other starchy crops, fruits, vegetables, etc). As discussed earlier, production information on these crops was only collected for households that harvested any in the last the last two weeks at the time of the survey. Thus, the estimated value of annual production, which is obtained by multiplying by 26, is less reliable. Also, we could not estimate the value of production of these crops for households that grew the crop but did not harvest any in the last the last two weeks at the time of the survey.

Impact of crops planted and use of purchased inputs. Compared to growing vegetables and others as the main farm crops, growing cocoa was associated with greater productivity in the coastal zone, while growing beans and tree crops were associated with greater productivity in the northern savannah zone, which is not surprising given the more developed market-orientation of these crops. There were no significant differences in productivity by the type of crops grown in the forest and southern savannah zones.

As expected, greater spending on purchased inputs had positive impacts on productivity. Table 3b shows that the marginal returns (or profitability) to use of purchased inputs are large and statistically significant, especially in the forest and savannah zones. None of the purchased inputs analyzed here was profitable in the coastal zone. These results show that investment in extension and other programs to promote use of fertilizers and pesticides will be important. However, as our earlier results show, adoption and intensity of using these inputs are constrained by lack of purchasing, given that these inputs are costly. Thus, providing credit to farmers to help them acquire the inputs will be important, as is improving their availability through investment in infrastructure and development of input markets.

The lack of profitability of improved seeds is not surprising. In a recent field trip to study maize supply chain, farmers revealed that they have been using the same seed without replacement for at least five years (Kolavalli et al. 2007). This significantly reduces their viability leading to yields that are not much different from the local or traditional varieties. During the field trip mentioned above, farmers also expressed concern about the viability of the seeds being produced on neighboring farms and marketed as certified seeds. Together with the above findings, increased investment in agriculture research that leads to the development of profitable technologies in local environments cannot be overemphasized. Increased investment also in extension and other training programs to promote proper use of improved seeds will be extremely important. Similarly, improving the availability of improved seeds and helping farmers to acquire those inputs will be important. Evidence of the benefits of investment in agriculture research and extension on agriculture productivity growth and poverty reduction is now common knowledge (see e.g. Evenson 2001; Alston et al. 2000; Evenson et al. 1999; Fan et al. 2000, 2004 and 2005; Fan and Zhang 2004; Fan and Rao 2003). As Figure 2 shows, however, Ghana has substantially reduced over time its spending on agriculture over in general and agriculture research in particular. Although agriculture contributes about 40% of total GDP, government spending on agriculture research is only about 0.2% of total GDP and 0.5 of total expenditure. These shares are much lower than the averages for sub-Saharan Africa, Asia and Latin America (see Fan and Rao 2003). With such low public on agriculture in general and agriculture research in particular, raising and maintaining high agriculture productivity is unlikely.



Sources of data: Government Finance Statistics (IMF 2007); World Development Indicators (World Bank 2007); Agriculture Science and Technology Indicators database (IFPRI 2007).

Figure 2. Government expenditure in agriculture, 1975-2004

Hired labor was profitable in the northern savannah zone only. This finding is also not surprising since the cost of hired labor seem unreasonably high. During the 2006 season for example, Kolavalli et al. (2007) shows that the cost of hired labor for land clearing or weeding was about 20,000–25,000 Cedis for 3–4 hours of work. However, due to moral hazard issues, most farmers preferred to hire labor on a contractual basis of 250,000–350,000 Cedis per acre for land preparation or weeding and about 80,000–100,000 Cedis per acre for sowing, fertilizer application, or weeding.[6] Interestingly, the cost of tractor services for land preparation (i.e. plowing or harrowing) was the same as for human labor. Similarly, the cost of using weedicides for land preparation or weeding (including the cost of chemicals, labor cost of sprayer, hiring a knapsack, etc.) was the same as of using hired manual labor. Thus, there seem to be no real cost-saving among alternative labor-intensive or capital-intensive technologies. With such high cost of labor, therefore, it is difficult to envisage how its use can be profitable even under current improved production practices, given the modest yield gap between the so called traditional and improved production practices of 600 only kg per acre for maize for example.[7]

The lack of profitability of spending on irrigation seems surprising. However, and as Table 1 shows, only 0.4% of the sample of households analyzed here used or spent any money on irrigation. Thus, there are not enough observations to warrant a reliable estimation in this paper. Nevertheless, the benefits of irrigation on raising agriculture productivity are widely documented and should be expected in Ghana as well. Institutional arrangements for effective delivery of irrigation services will, however, be important.

Most Ghanaian farmers perceive to have sufficient knowledge of the available technologies, their benefits, and how to use or apply them, and they also claim that availability of the technologies is not an issue (Kolavalli et al. 2007). However, as the descriptive statistics show in Table 1, farmers are selective on technologies they adopt and the extent to which they adopted them, depending on the cost, labor constraints, and access to and cost of credit (Kolavalli et al. 2007). The differences in profitability of the different purchased inputs across the different agroecological zones support this view, which also point to the need for promoting different technological packages for the different agroecologies. The one-sized-fits-all recommendations are simply wasteful of scarce resources.

Impact of farm size and fragmentation. The negative sign associated with the farm size suggests that small farms are more efficient in all four agroecological zones. The elasticity associated with farm size ranges from –0.36 in the northern savannah zone to –0.81 in the forest zone, suggesting that the farm size-productivity inefficiency is highest in the forest zone. These findings are consistent with those of several other studies, including the one by Fafchamps (19xx) that tenants with small

[6] Labor cost includes both cash payment (up to 95% of the total cost) and in-kind payments in the form of cooked meals.

[7] This is based on the yield estimate of 360–600 kg (or 3–5 bags) per acre and 960–1,200 kg (or 8–10 bags) per acre for traditional and improved varieties, respectively, where a bag weighs about 120 kg (range of 110 to 130 kg) (Kolavalli et al. 2007).

farms in Ghana have the highest cocoa yields. This does not mean that farm sizes must be reduced in order to increase productivity, as average farm sizes are already low. However, the results highlight the inability of households operating larger farmlands to take advantage of scale economies, especially in the procurement of inputs to realize lower unit costs or in using mechanization. The results also show that while the number of plots a household cultivates has a positive impact on productivity, lower concentration of the farmland in any one plot has a larger negative impact. Therefore, there are potential efficiency gains from having policies and strategies that will lead to consolidation of farmlands in the southern savannah and forest zones. However, the notion that farmers operate different plots located in different areas to minimize local bio-physical risks should be taken into account.

Impact of land tenure and rental markets. Compared to farmlands that were purchased or used free of charge, households with greater shares of rented plots in their farmland portfolio were associated with greater productivity in the coastal zone, while those with more village-distributed farmlands were associated with greater productivity in the coastal and northern savannah zones. Taking into consideration the earlier result that rented plots were associated with greater spending on purchased inputs, the lack of substantial greater productivity on rented plots than those purchased or used free of charge, with the exception of the coastal zone, suggests that rental markets, by helping to transfer land to those with more resources or capability to potentially improve the productivity of the land resource base, are raising the productivity of leased-in land and leading to equalization of productivity of farmlands, as found in other places (Benin et al. 2005). Therefore, policies that enhance the proper functioning of farmland rental markets where such markets already exist will be important.

Impact of household characteristics (gender, education, livelihoods, assets). We find that larger households, households with a greater proportion of their members employed, and male-headed households are associated with greater farm productivity. This is consistent with the earlier finding of those factors being associated with greater spending on purchased inputs. These findings again point to the vulnerability of female-headed households as well as small-sized households that are unable to hire labor to work on their farmlands. Ownership of assets also has positive impacts on productivity, which is consistent with the earlier finding of a positive impact of ownership of assets on spending on purchased inputs. Therefore, policies and programs that improve the asset base of households, especially of women, will be important in the raising agriculture productivity.

Impact of access to services and infrastructure. The main impact pathway of improvement in access to services and infrastructure on crop productivity and profitability is captured via its impact on use of purchased inputs by improving their availability as well as reducing their prices. These are called the indirect impact. For example, by improving access to fertilizers and pesticides, improving households' access to year-round access to roads and telephones (either fixed or mobile) will lead to substantial profitability gains.

Improving households' access to services and infrastructure also has direct (or additional) impacts, which may complement or detract from the indirect impacts. As Table 3a shows, households located in districts with better access to markets are associated with greater productivity, especially those in the coastal and northern savannah zones, likely due to higher output–input price ratios. Those located in the forest zone with better year-round access to roads or with access to telephones are associated with lower productivity, which is likely due to migration out of agriculture as improved accessibility opens up non-farm opportunities or creates exit options out of agriculture.

The impacts of access to agriculture extension and credit were not analyzed here since both the GLSSV and CWIQ datasets used here do not have information on them. Also, we were unable to obtain district level information on these variables form any secondary sources. However, during the field trip mentioned above (Kolavalli et al. 2007), we learned for example that the extension agents to farmer ratio in the forest and southern savannah zones was about 1 to 2,000–4,000 farmers, and very few of the extension agents had motorbikes (about 1 in 6), severely limiting their effective operation. Certainly, given the widely documented evidence of substantial positive impacts of agriculture extension on agricultural productivity at both the farm and aggregate levels, there is need to increase public investment in agriculture extension. Credit also was found to be very expensive. First or all, there was rarely any use of credit from formal financial institutions, where the cost credit is about 35% for a 10-month loan. Rather, farmers commonly used informal credit sources, especially through trader-farmer relationships, where the cost of credit ranged from 40% to 100% for a 4-month loan (i.e. for credit obtained at the beginning of the cropping season to be paid back at harvest time).[8]

Agriculture income per capita

Here also we focus the discussion on key variables only. Detail results of the regression are given in Table 4. Where the coefficients of the variables are statistically significant, the direction of impact on agriculture income per capita due to farm size, household size, households headed by old people, employment and ownership of assets is the same across all the four agroecological zones, where the coefficients associated with those variables are statistically significant. While farm size, employment and ownership of assets have positive impacts on agriculture income per capita, the others have negative impacts. These are consistent with our earlier findings regarding crop productivity, and means that policies and strategies that improve access to farmland, creates employment opportunities, and improves the asset endowment of households will contribute substantially to raising agricultural incomes across the board. However, since the magnitudes of the impacts differ across the agroecological zones, it means that different strategies for raising agricultural income will be required for the different zones. For example, an increase in the average farm size in

[8] The interest rate is based on the value of the number of bags of grain paid back as interest (Kolavalli et al. 2007).

the northern savannah zone is at least two times more efficient in raising agriculture income per capita than it is in the other zones. The elasticities associated with farm size are 0.88, 0.39, 0.36 and 0.13 for the northern savannah, coastal, forest and southern savannah zones, respectively.

Other factors, including farm fragmentation, land tenure, household income strategies, and access to services and infrastructure have different directions and magnitudes of impacts on agriculture income per capita across the different agroecologies, suggesting that policies and strategies that work well in raising agricultural income in certain areas will not work in other areas or have contradictory effects.

3. CONCLUSIONS AND IMPLICATIONS

Using data from the recent Ghana Living Standards Survey (GLSSV) to estimate the determinants of (i) adoption and intensity of adoption of purchased inputs, (ii) crop productivity, and (iii) agriculture income per capita, this paper analyzed the constraints and opportunities for promoting agriculture intensification and raising agriculture productivity and incomes in the different agroecologies of Ghana.

The results show that input applications (especially fertilizers and pesticides) was profitable in all but one zone (the coastal zone). Therefore, investment in extension and other programs to promote use of fertilizers and pesticides will be important. Of course, given that these inputs are costly, providing credit to farmers to help them acquire the inputs will be important, as is improving their availability through investment in infrastructure and development of input markets.

Improved seed, on the other hand, was not profitable in any zone, a finding that is not surprising. This is because farmers tend to use the same seed without replacing it for at least five years, a practice that significantly reduces their viability leading to yields that are not much different from those of the local or traditional varieties. Therefore, increased investment in agriculture research that leads to the development of profitable technologies in local environments cannot be overemphasized. Increased investment also in extension and other training programs to promote proper use of improved seeds will be extremely important, as is improving the availability of improved seeds and helping farmers to acquire them. The rationale for this intervention is supported by the large body of evidence of the benefits of investment in agriculture research and extension on agriculture productivity growth and poverty reduction in other regions of the world.

The main factors contributing to greater cropping intensification, i.e. greater input use per acre, include land rental markets, assets, gender, and labor availability (household size). Where they are used, land rental markets have promoted mobility of scarce resources by helping to transfer land to those with more resources or better capable of improving the land resource base, leading to greater

intensification of crop production. Therefore, policies that promote effective functioning of such markets where they are already developed will be beneficial.

Households with larger assets in terms of the number of tropical livestock units and value of farm equipment were associated with greater spending on several purchased inputs in most of the zones. Ownership of assets also had positive impacts on productivity in most of the zones. Assets, especially small livestock can be used to finance purchase of inputs either directly through their sale or indirectly as collateral to obtain credit. Thus, interventions that create more productive assets for households will be important for promoting agricultural intensification.

Male-headed households were associated with greater input use and farm productivity. Households headed by the elderly were associated with lower input use in some zones, while larger households were associated with greater farm productivity. Together, these findings suggest that households headed by females and the elderly as well as small-sized households that are unable to hire labor to work on their farmlands, will not be able to contribute or benefit from growth in the sector. Therefore, specific interventions targeting these households will be needed.

Improving access to services and infrastructure (especially markets, roads, education and health) is inevitable everywhere, as they necessary for overall growth in the sector and the economy as a whole. Although, it seems that the northern regions could benefit the most from improvement in these as access to these are very low.

The results also show many of the determinants of input use, crop productivity, and income were different in the different agroecological zones of Ghana, suggesting that different types of policies, strategies, and public investment strategies will be needed in different places to promote agricultural intensification, raise agricultural productivity growth, and increase incomes.

The *southern savannah zone* presents the greatest opportunity for intensifying and mechanizing agriculture production in terms of greater use of chemical fertilizers, pesticides, irrigation and tractors. A critical factor in expanding and sustaining the process will be developing and promoting improved seeds (especially of maize and pulses) that respond well to the purchased inputs and mechanization.

Strategies for the *forest zone* are similar to those of the southern savannah zone in terms of developing and promoting improved seeds that respond well to purchased inputs. The main crops here, however, include cocoa, other tree crops, and roots and tubers.

The superior market access and infrastructure development (especially road and transport) of the *coastal zone* make the production of vegetables, fruits, and other perishable crop products more opportunistic. Here, however, products that meet consumer preferences especially in the case of exports will be crucial. Therefore, developing and promoting seed technologies and agronomic practices that are consistent with such preferences will be needed. Furthermore, diversification into poultry and other non-farm income-earning activities will be important.

The *northern savannah zone* is the most challenging for development. It is characterized by large households (suggesting labor abundance), low education attainment levels, little non-agricultural occupation activities, and little use of and pesticides. Due to the poor market opportunities of the zone, use of purchased inputs (especially chemical fertilizers and pesticides) is not likely to profitable. Opportunities for development include diversification of the crop portfolio to include legumes that can be used for nutrient management, as well as livestock for both income and nutrient management. Therefore, developing and promoting improved seeds of the crops grown there that respond well to manure will be particularly.

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Table 1. Description of variables and summary statistics, by agroecological zone

	Total sample		Coastal		Forest		Southern savannah		Northern savannah	
Variable	Mean	Std. Err	Mean	Std. Err	Mean	Std. Err	Mean	Std. Err	Mean	Std. Err
Production and income										
Value of cereal crop (‘000 cedis/acre)	793.074	26.064	698.514	48.717	804.594	41.091	1,159.494	179.756	718.810	21.242
Value of all crop (‘000 cedis/acre)	2,453.881	225.473	2,838.317	197.234	2,657.243	145.153	2,933.169	330.393	1,920.773	619.921
Agriculture income (‘000 cedis per capita)	2,839.142	201.695	2,845.807	206.548	3,285.324	246.049	3,390.353	1,007.757	2,041.802	428.175
Input use (1=use, 0 not used)										
Improved seed	0.265	0.006	0.229	0.016	0.280	0.010	0.286	0.021	0.254	0.011
Chemical fertilizer	0.229	0.006	0.183	0.015	0.199	0.009	0.218	0.019	0.295	0.012
Organic fertilizer	0.076	0.004	0.034	0.007	0.058	0.005	0.035	0.009	0.131	0.009
Pesticides	0.288	0.007	0.199	0.015	0.459	0.011	0.266	0.021	0.091	0.007
Irrigation	0.004	0.001	0.010	0.004	0.004	0.001	0.002	0.002	0.002	0.001
Hired labor	0.542	0.007	0.471	0.019	0.646	0.010	0.692	0.022	0.380	0.012
Input use (‘000 cedis/acre)										
Improved seed	11.730	0.874	11.752	2.916	14.402	1.414	19.785	4.215	5.540	0.582
Chemical fertilizer	26.768	1.807	18.257	3.162	32.483	3.471	26.616	5.104	22.484	2.023
Organic fertilizer	7.736	1.027	6.009	1.995	7.811	1.397	2.017	0.604	10.097	2.400
Pesticides	26.378	1.887	21.872	3.961	39.705	2.945	51.427	12.642	2.058	0.267
Irrigation	1.053	0.851	0.290	0.153	0.195	0.098	8.912	8.912	0.248	0.218
Hired labor	80.560	3.871	63.573	6.848	102.299	5.858	153.132	20.782	35.627	5.457
Hand tools, maintenance	20.794	1.001	16.132	1.510	25.434	1.928	32.002	4.023	12.938	0.753
Farm factors										
Area cultivated (acres)	7.865	0.217	5.971	0.456	7.061	0.244	5.965	0.379	10.399	0.537
Number of farm plots	2.038	0.022	1.759	0.045	2.010	0.030	2.062	0.058	2.193	0.047
Farm fragmentation index	0.264	0.004	0.217	0.011	0.274	0.006	0.312	0.013	0.258	0.008
Tenure (cf.: purchased/used free)										
Rented	0.177	0.005	0.270	0.017	0.267	0.009	0.186	0.018	0.008	0.002
Distributed by village	0.494	0.007	0.524	0.019	0.472	0.010	0.310	0.021	0.568	0.013
Proportion planted to crops (cf.: vegetables, other)										
Cereals	0.247	0.006	0.158	0.013	0.147	0.007	0.207	0.016	0.441	0.011
Beans	0.070	0.003	0.006	0.002	0.009	0.002	0.031	0.006	0.197	0.009
Roots	0.289	0.006	0.390	0.017	0.340	0.009	0.556	0.020	0.093	0.006
Trees	0.188	0.005	0.271	0.016	0.148	0.007	0.130	0.013	0.226	0.010
Cocoa	0.167	0.005	0.103	0.011	0.330	0.009	0.045	0.008	0.000	0.000

Value adjustment (1 cultivated roots, etc but did not harvest in last 2 weeks; 0 otherwise)	0.393	0.007	0.447	0.019	0.244	0.009	0.393	0.023	0.579	0.013
Household factors										
Size	4.978	0.043	4.030	0.094	4.464	0.056	5.040	0.146	6.103	0.087
Gender of head (1=male, 0=female)	0.791	0.006	0.711	0.018	0.739	0.009	0.778	0.020	0.904	0.008
Proportion of males	0.510	0.004	0.503	0.011	0.515	0.006	0.514	0.012	0.504	0.005
Age of head	47.079	0.219	47.601	0.587	47.081	0.323	46.873	0.740	46.910	0.392
Proportion of members aged 18-64	0.511	0.004	0.528	0.012	0.513	0.006	0.486	0.012	0.508	0.006
Education (proportion of members) (cf.: none)										
Primary/middle	0.322	0.004	0.406	0.012	0.407	0.007	0.315	0.014	0.167	0.005
Secondary and greater	0.153	0.003	0.186	0.010	0.199	0.006	0.159	0.011	0.072	0.004
Number of days ill or injured	6.009	0.120	5.651	0.297	6.436	0.177	6.624	0.419	5.379	0.219
Proportion employed	0.583	0.004	0.573	0.011	0.565	0.006	0.546	0.012	0.624	0.006
Primary occupation (proportion of members) (cf.: subsistence)										
Market-oriented production	0.226	0.005	0.273	0.013	0.194	0.007	0.209	0.015	0.257	0.008
Other agricultural production	0.045	0.002	0.067	0.008	0.062	0.004	0.059	0.009	0.006	0.001
Non-agricultural activities	0.115	0.003	0.170	0.011	0.134	0.005	0.104	0.010	0.069	0.004
Total farmland owned (acres)	9.113	0.254	6.306	0.485	8.103	0.288	8.308	0.824	12.010	0.601
Tropical livestock units	1.537	0.108	0.637	0.124	0.386	0.037	1.354	0.312	3.611	0.312
Value of equipment (‘ 000 cedis)	282.508	38.849	173.845	63.977	170.889	21.866	395.196	98.367	453.933	111.035
District factors										
Annual average rainfall (mm)	1,292.871	3.272	1,330.903	11.054	1,453.288	2.946	1,259.547	3.597	1,059.825	2.003
Population density	91.152	2.494	182.175	10.706	104.664	4.134	40.719	1.663	47.259	1.027
Proportion of households within 15 minutes of water supply	0.761	0.002	0.817	0.004	0.858	0.002	0.735	0.007	0.608	0.003
Proportion of households within 15 minutes of market	0.397	0.004	0.521	0.011	0.525	0.004	0.404	0.012	0.161	0.002
Access to phones (1=yes, 0=no)	0.587	0.007	0.615	0.019	0.664	0.010	0.488	0.023	0.496	0.013
Proportion of households with year-round access to roads	0.525	0.003	0.669	0.008	0.592	0.005	0.365	0.008	0.416	0.005
Rural area (1=rural, 0=urban)	0.846	0.005	0.835	0.014	0.812	0.008	0.824	0.018	0.905	0.008
Regional location (cf.: western)										
Central	0.083	0.004	0.390	0.019	0.064	0.005	0.000	0.000	0.000	0.000
Greater Accra	0.011	0.002	0.082	0.011	0.000	0.000	0.000	0.000	0.000	0.000
Volta	0.098	0.004	0.211	0.016	0.098	0.006	0.262	0.021	0.000	0.000
Eastern	0.116	0.005	0.127	0.013	0.186	0.008	0.156	0.017	0.000	0.000

Ashanti	0.157	0.005	0.000	0.000	0.351	0.010	0.000	0.000	0.000	0.000
Brong-Ahafo	0.119	0.005	0.000	0.000	0.143	0.008	0.582	0.023	0.000	0.000
Northern	0.127	0.005	0.000	0.000	0.000	0.000	0.000	0.000	0.401	0.013
Upper East	0.097	0.004	0.000	0.000	0.000	0.000	0.000	0.000	0.306	0.012
Upper west	0.093	0.004	0.000	0.000	0.000	0.000	0.000	0.000	0.293	0.012
Quarter of survey (cf.: January-March)										
April-June	0.210	0.006	0.205	0.016	0.191	0.008	0.143	0.016	0.258	0.011
July-September	0.226	0.006	0.214	0.016	0.245	0.009	0.149	0.017	0.226	0.011
October-December	0.301	0.007	0.318	0.018	0.297	0.010	0.391	0.023	0.271	0.011
Year of survey (1=2006, 0=2005)	0.610	0.007	0.498	0.019	0.620	0.010	0.549	0.023	0.662	0.012
Number of observations	4768		663		2131		455		1519	

Sources: GLSSV; CWIQ 2003

Table 2a. Determinants of household spending on improved seeds, by agroecological zone

	Coastal		Forest		Southern savannah		Northern savannah	
	Coeff.	Sig.	Coeff.	Sig.	Coeff.	Sig.	Coeff.	Sig.
Farm factors								
Area cultivated (acres)	-25.224	***	-14.214		-46.884		-14.926	**
Number of farm plots	165.158	***	-36.795		29.471		42.970	***
Farm fragmentation index	-271.397	**	115.493	***	-70.581		-89.383	***
Tenure (cf.: purchased/used free)								
Rented	-2.215		8.683		106.612	***	-23.486	
Distributed by village	-55.637	**	-5.648		46.457		10.690	**
Household factors								
Size	-1.749		4.282		-2.235		8.776	*
Gender of head (1=male, 0=female)	-6.090		11.220		15.794		-5.887	
Proportion of males	1.380		-1.066		-65.796		1.929	
Age of head	-13.507		-30.885	**	34.744		-22.616	***
Proportion of members aged 18-64	58.851		13.460		81.673		-8.828	
Education (proportion of members) (cf.: none)								
Primary/middle	94.134	***	6.921		105.966	**	-13.507	
Secondary and greater	66.231		12.397		136.235	**	20.104	*
Number of days ill or injured	-1.935		1.094	**	1.184		-0.030	
Proportion employed	-108.396		-31.268		-112.253		24.141	**
Primary occupation (proportion of members) (cf.: subsistence)								
Market-oriented production	-74.173		-16.118		114.669		-12.553	
Other agricultural production	50.367		-34.518		-8.333		-11.148	
Non-agricultural activities	-101.459		18.861		45.354		-17.361	
Total farmland owned (acres)			9.381		29.998		0.950	
Tropical livestock units	-7.577		1.346		-4.833		-0.207	
Value of equipment (‘ 000 cedis)	0.011	**	0.001		0.005		0.000	
District factors								
Annual average rainfall (mm)	207.662		-13.659		-735.007		69.854	
Population density	82.034	***	2.143		-29.113		7.378	*
Proportion of households within 15 minutes of water supply	-123.077		-241.113	***	156.416		-56.960	**
Proportion of households within 15 minutes of market	1.345		135.718	***			125.661	***
Access to phones (1=yes, 0=no)	-40.293		32.242	***	68.758	**	15.050	***
Proportion of households with year-round access to roads	-238.707	**	-66.227	**	-23.952		-40.259	***
Rural area (1=rural, 0=urban)	8.158		-22.820	**	-32.562		1.053	
Regional location (cf.: western)								
Central	-4.599		-19.170					

Greater Accra	63.720							
Volta	-5.824		33.012					
Eastern	0.804		-0.820		-107.893	*		
Ashanti			33.158					
Brong-Ahafo			27.576		-212.764	***		
Northern								
Upper East							12.968	
Upper west							-30.074	***
Quarter of survey (cf.: January-March)								
April-June	-50.136		-2.119		97.116	**	-8.247	
July-September	84.100		24.834	*	186.376	**	-11.159	*
October-December	9.880		-18.613		181.212	*	-17.928	*
Year of survey (1=2006, 0=2005)	55.676		0.947		117.546		-29.403	***
Intercept	-1698.052		235.415		4855.853		-412.051	
Chi-square	88.670	***	134.690	***	82.980	***	244.800	***
Sigma	171.304	***	142.034	***	177.469	***	50.194	***
Number of positive observations (total)	150 (663)		598 (2131)		130 (455)		386 (1519)	

Tobit regression. Dependent variable is '000 cedis per acre. Ln means transformation by natural logarithm. *, ** and *** means significance at the 10%, 5% and 1% level, respectively.

Source of data: GLSSV and CWIQ 2003.

Table 2b. Determinants of household spending on inorganic fertilizers, by agroecological zone

	Coastal		Forest		Southern savannah		Northern savannah	
	Coeff.	Sig.	Coeff.	Sig.	Coeff.	Sig.	Coeff.	Sig.
Farm factors								
Area cultivated (acres)	1.541		-57.121	*	132.960	***	35.125	
Number of farm plots	-13.631		80.432		-52.038		17.112	
Farm fragmentation index	14.602		3.535		257.893		-26.218	
Tenure (cf.: purchased/used free)								
Rented	21.340		113.829	***	28.573		-55.120	
Distributed by village	-18.216		62.441	*	100.613	**	-14.160	
Household factors								
Size	-40.224		-18.515		132.645	***	9.640	
Gender of head (1=male, 0=female)	111.001	***	117.190	***	-3.448		30.311	
Proportion of males	-108.403	*	-88.974		14.034		-24.845	
Age of head	-34.951		-35.402		27.136		-11.918	
Proportion of members aged 18-64	47.178		73.378		69.983		-3.073	
Education (proportion of members) (cf.: none)								
Primary/middle	67.882		-8.782		112.829		1.263	
Secondary and greater	71.408		-52.421		175.346	*	105.137	***
Number of days ill or injured	1.426		0.863		3.393	*	-0.897	
Proportion employed	-175.978		-155.723		306.138	***	23.039	
Primary occupation (proportion of members) (cf.: subsistence)								
Market-oriented production	-44.814		-36.770		-84.060		-15.419	
Other agricultural production	105.457		-70.795		-194.192		203.084	**
Non-agricultural activities	8.671		-35.419		-40.037		167.541	***
Total farmland owned (acres)			74.365	**	-112.157	**	-17.892	
Tropical livestock units	6.537	*	15.782	***	-4.078		-0.118	
Value of equipment (‘ 000 cedis)	0.006		0.029	***	0.005		0.002	
District factors								
Annual average rainfall (mm)	499.932	*	-217.897		687.729		-550.611	**
Population density	89.059	**	-46.162		47.272		-11.573	
Proportion of households within 15 minutes of water supply	72.271		-55.500		-93.394		1.195	
Proportion of households within 15 minutes of market	-257.265	***	-289.032	***			-310.588	***
Access to phones (1=yes, 0=no)	-40.462		22.769		242.048	***	1.395	
Proportion of households with year-round access to roads	-699.056	***	-71.088		132.404		-155.680	***
Rural area (1=rural, 0=urban)	122.202	**	-24.876		13.717		-31.546	
Regional location (cf.: western)								
Central	279.357	***	-30.371					

Greater Accra	502.491	***						
Volta	19.789		-309.496	***				
Eastern	205.048	**	-73.039		49.943			
Ashanti			9.395					
Brong-Ahafo			54.767		156.105	**		
Northern								
Upper East							-104.018	***
Upper west							-120.829	***
Quarter of survey (cf.: January-March)								
April-June	-77.650		182.262	***	-187.047	***	-63.933	***
July-September	-121.405		7.410		-36.235		-61.479	***
October-December	-238.440	***	1.210		-234.222	*	-72.625	**
Year of survey (1=2006, 0=2005)	-291.005	***	-138.415	**	-219.668	**	-75.165	***
Intercept	-3545.675		1729.891		-5930.203		4034.843	**
Chi-square	147.690	***	240.060	***	104.910	***	165.680	***
Sigma	211.126	***	408.445	***	245.789	***	166.379	***
Number of positive observations (total)	120 (663)		422 (2131)		99 (455)		447 (1519)	

Tobit regression. Dependent variable is '000 cedis per acre. Ln means transformation by natural logarithm. *, ** and *** means significance at the 10%, 5% and 1% level, respectively.

Source of data: GLSSV and CWIQ 2003.

Table 2c. Determinants of household spending on pesticides (insecticides and herbicides), by agroecological zone

	Coastal		Forest		Southern savannah		Northern savannah	
	Coeff.	Sig.	Coeff.	Sig.	Coeff.	Sig.	Coeff.	Sig.
Farm factors								
Area cultivated (acres)	-24.319		-57.264	***	-66.926		-2.401	
Number of farm plots	136.855		26.016		463.350	***	-15.983	
Farm fragmentation index	-125.198		-26.232		-573.050	*	48.646	*
Tenure (cf.: purchased/used free)								
Rented	58.616		71.336	***	-88.071		39.205	**
Distributed by village	7.379		26.207	*	-94.096		7.323	
Household factors								
Size	58.353		18.292		198.643	***	10.859	*
Gender of head (1=male, 0=female)	43.527		79.552	***	74.549		-5.900	
Proportion of males	24.576		-17.218		385.938	***	4.665	
Age of head	-23.847		-67.136	***	-200.194	**	7.606	
Proportion of members aged 18-64	212.352	**	15.046		-106.410		1.856	
Education (proportion of members) (cf.: none)								
Primary/middle	79.399		14.160		218.657	*	18.158	
Secondary and greater	69.878		14.060		284.340	**	66.136	***
Number of days ill or injured	4.165	**	0.085		-0.050		-0.476	*
Proportion employed	-56.470		24.852		614.520	***	-10.484	
Primary occupation (proportion of members) (cf.: subsistence)								
Market-oriented production	-25.371		-64.264	***	-521.625	***	3.505	
Other agricultural production	-17.628		46.687		234.875		50.682	
Non-agricultural activities	-39.679		-35.216		-389.687	***	28.742	*
Total farmland owned (acres)			58.588	***	46.294		5.300	
Tropical livestock units	2.834		4.118		-0.503		0.231	*
Value of equipment (‘ 000 cedis)	0.012	*	0.012	***	-0.016		0.001	**
District factors								
Annual average rainfall (mm)	629.378	**	43.382		-3559.872	***	-325.036	***
Population density	0.821		-16.941		534.358	***	-6.114	
Proportion of households within 15 minutes of water supply	82.745		-101.745		-850.546		-50.610	*
Proportion of households within 15 minutes of market	-57.656		-62.212				44.838	
Access to phones (1=yes, 0=no)	-50.273		-6.013		400.622	***	-3.407	
Proportion of households with year-round access to roads	-111.858		11.869		347.382		-13.242	
Rural area (1=rural, 0=urban)	179.920	***	41.120	***	77.865		0.791	
Regional location (cf.: western)								
Central	224.721	**	-38.350					

Greater Accra	613.807	***						
Volta	343.036	*	-33.438					
Eastern	481.721	***	-15.510		63.453			
Ashanti			12.845					
Brong-Ahafo			39.233		149.565			
Northern								
Upper East							-47.666	***
Upper west							-23.313	**
Quarter of survey (cf.: January-March)								
April-June	78.127		106.264	***	-363.257	***	4.811	
July-September	-23.158		75.607	***	356.477	***	-6.829	
October-December	-23.814		48.400		214.740		-7.488	
Year of survey (1=2006, 0=2005)	-75.266		-21.039		342.980	***	-28.589	***
Intercept	-5315.571	**	-167.143		22968.920	**	2224.653	***
Chi-square	128.130	***	217.140	***	246.770	***	124.080	***
Sigma	254.375	***	216.093	***	345.605	***	47.108	***
Number of positive observations (total)	130 (663)		976 (2131)		121 (455)		139 (1519)	

Tobit regression. Dependent variable is '000 cedis per acre. Ln means transformation by natural logarithm. *, ** and *** means significance at the 10%, 5% and 1% level, respectively.

Source of data: GLSSV and CWIQ 2003.

Table 2d. Determinants of household spending on hired labor, by agroecological zone

	Coastal		Forest		Southern savannah		Northern savannah	
	Coeff.	Sig.	Coeff.	Sig.	Coeff.	Sig.	Coeff.	Sig.
Farm factors								
Area cultivated (acres)	-23.076	*	-233.739	***	-247.691	***	-34.948	
Number of farm plots	51.830		127.401	***	-86.854		33.667	
Farm fragmentation index	-43.097		-136.168		206.678		39.473	
Tenure (cf.: purchased/used free)								
Rented	72.523	*	58.365	***	183.936	**	0.292	
Distributed by village	-0.982		-20.222		44.874		-91.531	***
Household factors								
Size	-14.426		16.319		78.138		67.812	***
Gender of head (1=male, 0=female)	-2.270		52.404	**	-134.762		-13.160	
Proportion of males	-84.544		-75.931	**	-1.850		-6.866	
Age of head	-26.776		37.822		51.006		-58.267	
Proportion of members aged 18-64	9.301		-25.501		-141.754		-15.117	
Education (proportion of members) (cf.: none)								
Primary/middle	67.810		88.298	***	342.042	***	-102.061	
Secondary and greater	27.789		96.798	***	192.900		6.867	
Number of days ill or injured	4.982	***	0.143		3.308		0.757	
Proportion employed	1.829		53.106		4.194		92.471	
Primary occupation (proportion of members) (cf.: subsistence)								
Market-oriented production	-146.825	*	-147.147	***	136.579		27.098	
Other agricultural production	-98.889		-18.433		66.319		126.308	
Non-agricultural activities	-77.613		3.308		78.823		263.089	***
Total farmland owned (acres)			150.689	***	214.494	***	28.289	
Tropical livestock units	0.128		10.054	***	1.371		0.644	
Value of equipment (‘ 000 cedis)	0.010		0.016	**	-0.011		0.004	
District factors								
Annual average rainfall (mm)	-336.899		-400.025	***	-164.198		1543.949	***
Population density	-78.508	*	0.172		-64.103		-53.417	***
Proportion of households within 15 minutes of water supply	455.649	*	-99.976		-593.779		-45.299	
Proportion of households within 15 minutes of market	200.189	*	-169.312	***			-348.524	
Access to phones (1=yes, 0=no)	-10.368		43.239	**	-54.527		23.249	
Proportion of households with year-round access to roads	-17.331		62.887		282.569		175.529	**
Rural area (1=rural, 0=urban)	-89.825	**	22.624		-14.330		-47.046	
Regional location (cf.: western)								
Central	70.514		-55.464					

Greater Accra	-35.030							
Volta	57.090		-184.596	***				
Eastern	-21.793		-63.756	*	93.134			
Ashanti			-78.454	*				
Brong-Ahafo			-63.662		-3.784			
Northern								
Upper East							206.135	***
Upper west							38.152	
Quarter of survey (cf.: January-March)								
April-June	16.861		86.461	***	241.056	**	33.829	
July-September	-107.390		34.223		181.638		83.245	**
October-December	-115.981		66.941		539.973	***	116.657	*
Year of survey (1=2006, 0=2005)	-191.047	*	90.276	***	373.683	**	130.810	**
Intercept	2599.662		2817.730	***	888.950		-10871.070	***
Chi-square	90.650	***	301.410	***	49.270	**	163.390	***
Sigma	272.078	***	327.007	***	526.728	***	361.391	***
Number of positive observations (total)	311 (663)		1377 (2131)		315 (455)		577 (1519)	

Tobit regression. Dependent variable is '000 cedis per acre. Ln means transformation by natural logarithm. *, ** and *** means significance at the 10%, 5% and 1% level, respectively.

Source of data: GLSSV and CWIQ 2003.

Table 3a. Determinants of value of crop (staple grains, field and cash crops) production per acre

	Coastal		Forest		Southern savannah		Northern savannah	
	Coeff.	Sig.	Coeff.	Sig.	Coeff.	Sig.	Coeff.	Sig.
Farm factors								
Area cultivated (acres)	-0.585	***	-0.813	***	-0.801	***	-0.359	***
Number of farm plots	-0.041		0.538	***	0.798	*	-0.079	
Farm fragmentation index	0.531		-0.641	**	-1.966	***	0.005	
Tenure (cf.: purchased/used free)								
Rented	0.368	***	0.016		-0.061		0.364	
Distributed by village	0.399	***	-0.085		0.239		0.117	***
Proportion planted to crops (cf.: vegetables, other)								
Cereals	0.200		-0.070		0.808		0.223	
Beans	0.493		0.639		0.822		0.408	***
Roots	-0.090		-0.327		0.310		0.288	*
Trees	0.150		-0.371		-0.386		0.297	*
Cocoa	0.952	***	0.282		0.911			
Input use (‘000 cedis/acre)								
Improved seed	0.040		-0.041	**	0.007		-0.019	
Chemical fertilizer	-0.058		0.059	***	0.132	***	0.076	***
Organic fertilizer	0.101		0.083	***	0.197	**	0.111	***
Pesticides	0.017		0.087	***	0.103	**	0.035	
Irrigation	-0.050		-0.129		-0.090		0.089	
Hired labor	0.051	**	0.051	***	0.069	***	0.095	***
Hand tools, maintenance	-0.020		0.026		0.016		0.039	***
Household factors								
Size	0.245	**	0.111	*	0.334	**	0.268	***
Gender of head (1=male, 0=female)	0.069		0.357	***	0.232		0.261	***
Proportion of males	0.389	*	0.040		0.220		-0.050	
Age of head	-0.071		0.270	***	-0.172		-0.107	
Proportion of members aged 18-64	-0.101		-0.112		0.194		0.194	*
Education (proportion of members) (cf.: none)								
Primary/middle	-0.102		-0.017		0.289		-0.017	
Secondary and greater	0.182		0.095		-0.075		-0.038	
Number of days ill or injured	0.011	*	-0.001		-0.004		-0.006	**
Proportion employed	0.067		0.577	***	0.557		0.076	
Primary occupation (proportion of members) (cf.: subsistence)								
Market-oriented production	0.362		0.004		-0.029		0.103	

Other agricultural production	0.341		-0.063		0.675		-0.238	
Non-agricultural activities	0.733	***	-0.250	*	-0.460		-0.132	
Total farmland owned (acres)			0.337	***	0.231		-0.144	*
Tropical livestock units	0.016		0.027	*	0.017		0.005	***
Value of equipment (‘ 000 cedis)	0.000		0.000	***	0.000		0.000	*
District factors								
Annual average rainfall (mm)	-0.599		-1.549	***	-1.629		-0.013	
Population density	0.208		-0.139	**	0.015		0.079	**
Proportion of households within 15 minutes of water supply	-3.098	***	-0.903	**	-1.019		0.340	
Proportion of households within 15 minutes of market	0.734	*	0.276				2.830	***
Access to phones (1=yes, 0=no)	-0.098		-0.227	***	0.016		-0.055	
Proportion of households with year-round access to roads	-0.770		-0.383	**	-0.673		0.192	
Rural area (1=rural, 0=urban)	-0.575	***	-0.100		0.195		0.326	***
Regional location (cf.: western)								
Central	-0.181		-0.251	*				
Greater Accra	0.305							
Volta	0.118		0.117					
Eastern	0.600	*	-0.158		0.127			
Ashanti			-0.232	*				
Brong-Ahafo			-0.348	**	0.073			
Northern								
Upper East							-0.178	
Upper west							-0.061	
Quarter of survey (cf.: January-March)								
April-June	0.412	**	0.097		-0.359		0.018	
July-September	0.113		0.213	***	-0.262		0.215	***
October-December	-0.156		0.162		-0.321		0.104	
Year of survey (1=2006, 0=2005)	0.135		0.197	*	-0.108		0.067	
Intercept	11.445		17.274	***	17.845		4.813	
F	8.440	***	15.460	***	6.150	***	21.920	***
R-squared	0.424		0.292		0.437		0.401	
Number of observations	663		2131		455		1519	

Ordinary least squares regression. Dependent variable is natural log of ‘000 cedis per acre. Ln means transformation by natural logarithm. *, ** and *** means significance at the 10%, 5% and 1% level, respectively.

Source of data: GLSSV and CWIQ 2003.

Table 3b. Marginal returns in crop value to spending on purchased inputs

	Coastal		Forest		Southern savannah		Northern savannah	
	Cedis per 1000 cedis spent	Sig.	Cedis per 1000 cedis spent	Sig.	Cedis per 1000 cedis spent	Sig.	Cedis per 1000 cedis spent	Sig.
Improved seed	2,378		-2,291	**	410		-2,465	
Chemical fertilizer	-2,219		1,461	***	5,750	***	2,430	***
Organic fertilizer	11,741		8,550	***	113,248	**	7,902	***
Pesticides	543		1,763	***	2,322	**	12,225	
Irrigation	-120,433		-532,270		-11,709		257,960	
Hired labor	560	**	401	***	522	***	1,917	***
Hand tools, maintenance	-866		822		580		2,167	***

Source of data: Model results in Table 3a.

Table 3c. Determinants of value of total crop production per acre

	Coastal		Forest		Southern savannah		Northern savannah	
	Coeff.	Sig.	Coeff.	Sig.	Coeff.	Sig.	Coeff.	Sig.
Farm factors								
Area cultivated (acres)	-0.566	***	-0.839	***	-0.663	***	-0.101	
Number of farm plots	-0.547	*	0.334	***	-0.366		-0.205	
Farm fragmentation index	1.545	***	-0.062		0.335		0.198	
Tenure (cf.: purchased/used free)								
Rented	0.127		-0.095		-0.293	*	0.042	
Distributed by village	0.321	***	-0.008		0.245		0.115	**
Proportion planted to crops (cf.: vegetables, other)								
Cereals	-0.706	***	-0.295		0.583		0.118	
Beans	1.141		-0.324		0.617		0.282	
Roots	-0.496	**	-0.224		0.531		0.343	*
Trees	-0.279		-0.099		0.103		0.390	**
Cocoa	-0.118		0.004		0.503			
Value adjustment (1 cultivated roots, etc but did not harvest in last 2 weeks; 0 otherwise)	-0.737	***	-0.587	***	-0.533	***	-0.366	***

Input use (‘000 cedis/acre)								
Improved seed	0.051		-0.009		-0.022		0.015	
Chemical fertilizer	-0.018		0.038	***	0.076	**	0.112	***
Organic fertilizer	-0.060		0.048	**	0.034		0.133	***
Pesticides	0.091	***	0.036	***	0.075	*	0.050	*
Irrigation	-0.011		-0.002		-0.104		0.004	
Hired labor	0.061	***	0.046	***	0.101	***	0.090	***
Hand tools, maintenance	-0.057	*	0.080	***	0.091	***	0.053	***
Household factors								
Size	0.226	*	0.241	***	0.244	*	0.327	***
Gender of head (1=male, 0=female)	0.112		0.131	**	0.023		0.161	*
Proportion of males	0.069		0.060		0.471	*	-0.038	
Age of head	-0.295	*	0.114		-0.380	*	-0.153	**
Proportion of members aged 18-64	-0.093		0.205	**	-0.300		0.114	
Education (proportion of members) (cf.: none)								
Primary/middle	0.109		0.025		0.138		0.005	
Secondary and greater	-0.299		-0.041		-0.265		-0.193	
Number of days ill or injured	0.001		-0.002		-0.004		-0.005	
Proportion employed	0.100		0.434	***	0.642	*	0.242	*
Primary occupation (proportion of members) (cf.: subsistence)								
Market-oriented production	0.278		-0.150		-0.372		0.125	
Other agricultural production	0.523		-0.052		0.493		-0.399	
Non-agricultural activities	0.365		-0.365	***	-0.413		-0.486	***
Total farmland owned (acres)			0.295	***	0.203		-0.342	***
Tropical livestock units	-0.004		0.030	***	0.011		0.006	***
Value of equipment (‘ 000 cedis)	0.000		0.000	***	0.000		0.000	
District factors								
Annual average rainfall (mm)	-1.081		-0.736	*	-1.609		0.356	
Population density	0.063		0.034		0.424	***	0.156	***
Proportion of households within 15 minutes of water supply	-0.757		-1.463	***	-0.156		-0.544	*
Proportion of households within 15 minutes of market	0.162		0.446	***			3.607	***
Access to phones (1=yes, 0=no)	-0.146		-0.107	**	0.053		-0.081	
Proportion of households with year-round access to roads	-0.668		-0.203		-0.179		0.119	
Rural area (1=rural, 0=urban)	-0.140		0.016		0.228		0.553	***
Regional location (cf.: western)								
Central	-0.205		-0.155					
Greater Accra	-0.074							
Volta	-0.813		-0.120					
Eastern	0.332		-0.058		-0.804	***		

Ashanti			-0.256	**				
Brong-Ahafo			-0.016		-0.031			
Northern								
Upper East							-0.150	
Upper west							-0.197	
Quarter of survey (cf.: January-March)								
April-June	-0.353	*	0.106		-0.309		-0.077	
July-September	-0.380		0.177	***	0.423		0.085	
October-December	-0.040		-0.025		-0.477		-0.101	
Year of survey (1=2006, 0=2005)	-0.142		0.039		-0.478		-0.379	***
Intercept	17.650	**	12.950	***	18.034		3.169	
F	8.690	***	23.640	***	6.880	***	25.000	***
R-squared	0.429		0.386		0.465		0.433	
Number of observations	663		2131		455		1519	

Ordinary least squares regression. Dependent variable is natural log of '000 cedis per acre. Ln means transformation by natural logarithm. *, ** and *** means significance at the 10%, 5% and 1% level, respectively.

Source of data: GLSSV and CWIQ 2003.

Table 4. Determinants of agriculture income per capita

	Coastal		Forest		Southern savannah		Northern savannah	
	Coeff.	Sig.	Coeff.	Sig.	Coeff.	Sig.	Coeff.	Sig.
Farm factors								
Area cultivated (acres)	0.389	***	0.131	**	0.358	***	0.878	***
Number of farm plots	-0.203		0.287	**	-0.331		-0.331	***
Farm fragmentation index	1.173	**	0.124		0.443		0.517	*
Tenure (cf.: purchased/used free)								
Rented	0.179		0.050		-0.120		0.119	
Distributed by village	0.338	***	0.017		0.216		0.075	
Value adjustment (1 cultivated roots, etc but did not harvest in last 2 weeks; 0 otherwise)	-0.698	***	-0.563	***	-0.385	***	-0.305	***
Household factors								
Size	-0.727	***	-0.735	***	-0.641	***	-0.582	***
Gender of head (1=male, 0=female)	0.119		0.163	***	0.185		0.232	***
Proportion of males	0.141		-0.062		0.329		0.005	
Age of head	-0.391	***	0.050		-0.592	***	-0.187	***
Proportion of members aged 18-64	-0.184		0.194	*	-0.750	***	0.156	
Education (proportion of members) (cf.: none)								
Primary/middle	0.189		0.067		0.291		-0.047	
Secondary and greater	-0.204		0.050		0.059		0.034	
Number of days ill or injured	0.006		0.001		0.005		-0.005	*
Proportion employed	0.062		0.402	***	0.725	*	0.377	***
Primary occupation (proportion of members) (cf.: subsistence)								
Market-oriented production	0.161		-0.220	**	-0.282		-0.113	
Other agricultural production	0.658	*	0.078		1.090	***	0.651	
Non-agricultural activities	0.212		-0.439	***	-0.291		-0.343	**
Total farmland owned (acres)			0.322	***	0.048		-0.358	***
Tropical livestock units	-0.001		0.033	***	0.015	*	0.010	***
Value of equipment (‘ 000 cedis)	0.000	**	0.000	***	0.000		0.000	**
District factors								
Annual average rainfall (mm)	-0.972		-1.207	***	-5.174	***	0.699	
Population density	-0.001		0.059		0.462	***	0.076	
Proportion of households within 15 minutes of water supply	0.065		-1.454	***			-0.949	***
Proportion of households within 15 minutes of market	0.113		0.075		-0.114		3.249	***
Access to phones (1=yes, 0=no)	-0.210	*	-0.103	**	0.177		-0.057	
Proportion of households with year-round access to roads	-0.709	*	-0.141		0.121		0.069	

Rural area (1=rural, 0=urban)	-0.088		0.024		0.244		0.605	***
Regional location (cf.: western)								
Central	0.038		-0.280	***				
Greater Accra	0.177							
Volta	-0.599		-0.427	***				
Eastern	0.498	*	-0.207	**	-0.056			
Ashanti			-0.449	***				
Brong-Ahafo			-0.156		-0.078			
Northern								
Upper East							-0.073	
Upper west							-0.209	*
Quarter of survey (cf.: January-March)								
April-June	-0.120		0.182	***	-0.084		-0.152	**
July-September	-0.142		0.232	***	0.376		0.003	
October-December	0.254		0.042		-0.404		-0.137	
Year of survey (1=2006, 0=2005)	0.054		0.117		-0.194		-0.459	***
Intercept	16.082	***	16.832	***	44.670	***	1.951	
F	13.730	***	51.680	***	7.060	***	29.570	***
R-squared	0.434		0.477		0.356		0.404	
Number of observations	663		2131		455		1519	

Ordinary least squares regression. Dependent variable is natural log of '000 cedis per capita. Ln means transformation by natural logarithm. *, ** and *** means significance at the 10%, 5% and 1% level, respectively.

Source of data: GLSSV and CWIQ 2003.

Annex 1. Agroecological zones

Coastal zone		Forest zone		Southern savannah zone		Northern savannah zone	
Region	District	Region	District	Region	District	Region	District
Western	Jomoro	Western	Mpohor-	Volta	Kadjebi	Northern	Bole
	Nzema E		Wassa W		Nkwanta		West Go
	Ahanta		Wassa A		Krachi		East Go
	Sekondi		Aowin	Eastern	Manya K		Nanumba
Central	KEEA		Juabeso		Asuogya		Zabzugu
	Cape Co		Sefwi W		Afram P		Cherepo
	Abura/A		Bibiani	Brong Ahafo	Jaman		East Da
	Mfantsi	Central	Assin		Wenchi		Gushieg
	Gomoa		Twifo/H		Nkoranz		Savelug
	Efutu/E		Upper D		Kintamp		Tamale
	Agona	Volta	Ho		Atebubu		Tolon
	Asikuma		Hohoe		Sene		West Ma
	Ajumako		Kpando				East Ma
Greater Accra	AMA		Jasikan			Upper East	Builsa
	Ga	Eastern	Birim N				Kassena
	Dangbe		Birim S				Bongo
	Dangbe		West Ak				Bolgata
Volta	South T		Kwaebib				Bawku W
	Keta		Suhum/K				Bawku E
	Ketu		East Ak			Upper West	Wa
	Akatsi		Fanteak				Nadowli
	NorthTo		Kwahu S				Sissala
Eastern	New Jua	Ashanti	Atwima				Jirapa-
	Akuapim		Amansie				Lawra
	Akuapim		Amansie				
	Yilo Kr		Adansi				
			Adansi				
			Ashanti				
			Ashanti				
			Ejusu/J				
			Bosomtw				
			KMA				
			Afigya/				
			Afigya				
			Sekyere				
			Sekyere				
			Ejura/S				
			Offinso				
			Ahafo-A				
			Ahafo-A				
		Brong Ahafo	Asunafo				
			Asutifi				
			Tanoso				
			Sunyani				
			Dormaa				
			Berekum				
			Techima				

Annex 2. Crops

Crop group	Crops
Cereals	Guinea corn, sorghum, maize, millet, rice
Vegetables	Garden egg/egg plant, leafy vegetables, okro, onion, pepper, tomatoes, other vegetables
Trees and fruits	Avocado pear, bananas, cashew nut, coconut, coffee, cola nut, citrus, mango, oil palm, pawpaw, pineapples, rubber, Shea nut, water melon, woodlot, other fruits
Pulses and nuts	Beans/peas, groundnuts, peanuts
Roots and starch	Cassava, cocoyam, plantain, potatoes, sweet potatoes, yam
Cocoa	Cocoa
Other	Cotton, ginger, kenef, sugarcane, tiger nut, other crops